Seagate®

Product Manual

Constellation® ES Serial ATA

ST32000644NS
ST31000524NS
ST3500514NS

100516232
Rev. F
August 2010

Revision history

Revision	Date	Sheets affected or comments
Rev. A	08/26/09	Initial release.
Rev. B	09/23/09	3-4, 6 and 13.
Rev. C	01/11/10	4, 13, 16 and 20.
Rev. D	04/21/10	1, 5, 9-11,14-15 & 17-18.
Rev. E	06/16/10	5 & 17-18.
Rev. F	08/02/10	6 & 31.

Publication number: 100516232, Rev. F, August 2010

When referring to drive capacity one gigabyte, or GB, equals one billion bytes and one megabyte, or MB, equals one million bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Seagate reserves the right to change, without notice, product offerings or specifications.

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SEAGATE ONLINE SUPPORT and SERVICES

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2.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following Seagate Constellation® ES Serial ATA model drives:

ST32000644NS ST31000524NS ST3500514NS

These drives provide the following key features:

- 7200 RPM spindle speed.
- PowerChoice™ for selectable power savings
- Top Cover Attached motor for excellent vibration tolerance
- High instantaneous (burst) data-transfer rates (up to 300MB per second).
- Perpendicular recording technology provides the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queueing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- SeaTools™ diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Worldwide Name (WWN) capability uniquely identifies the drive.

2.1 About the Serial ATA interface

The Serial ATA interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:

- Easy installation and configuration with true plug-and-play connectivity. It is not necessary to set any jumpers or other configuration options.
- Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
- Scalability to higher performance levels.

In addition, Serial ATA makes the transition from parallel ATA easy by providing legacy software support. Serial ATA was designed to allow you to install a Serial ATA host adapter and Serial ATA disc drive in your current system and expect all of your existing applications to work as normal.

The Serial ATA interface connects each disc drive in a point-to-point configuration with the Serial ATA host adapter. There is no master/slave relationship with Serial ATA devices like there is with parallel ATA. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. This essentially means both drives behave as if they are Device 0 (master) devices.

Note. The host adapter may, optionally, emulate a master/slave environment to host software where two devices on separate Serial ATA ports are represented to host software as a Device 0 (master) and Device 1 (slave) accessed at the same set of host bus addresses. A host adapter that emulates a master/slave environment manages two sets of shadow registers. This is not a typical Serial ATA environment.

The Serial ATA host adapter and drive share the function of emulating parallel ATA device behavior to provide backward compatibility with existing host systems and software. The Command and Control Block registers, PIO and DMA data transfers, resets, and interrupts are all emulated.

The Serial ATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All Serial ATA devices behave like Device 0 devices. For additional information about how Serial ATA emulates parallel ATA, refer to the “Serial ATA: High Speed Serialized AT Attachment” specification. The specification can be downloaded from www.serialata.org.

3.0 Drive specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the following drive models:

ST32000644NS ST31000524NS ST3500514NS

3.1 Specification summary tables

The specifications listed in the following tables are for quick reference. For details on specification measurement or definition, see the appropriate section of this manual.

Table 1: Drive specifications summary

Drive specification	ST32000644NS	ST31000524NS	ST3500514NS
Formatted (512 bytes/sector)*	2TB	1TB	500GB
Guaranteed sectors	3,907,029,168	1,953,525,168	976,773,168
Heads	8	4	2
Discs	4	2	1
Bytes per sector	512		
Default sectors per track	63		
Default read/write heads	16		
Default cylinders	16,383		
Recording density, KBPI (Kb/in max)	1421		
Track density, KTPI (ktracks/in avg.)	240		
Areal density, (Gb/in^2 avg)	347		
Spindle speed (RPM)	7200		
Internal data transfer rate (Mb/s max)	1300		
Sustained data transfer rate OD (MB/s max)	140		
I/O data-transfer rate (MB/s max)	300		
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6		
Cache buffer	64MB	32MB	
Height (mm max)	26.1mm (1.028 in)		
Width (mm max)	101.6mm (4.000 in) +/- 0.010 in		
Length (mm max)	146.99mm (5.787 in)		
Weight (max)	710g (1.565 lb)	640g (1.411 lb)	610g (1.345 lb)
Average latency	4.16ms		

Drive specification	ST32000644NS	ST31000524NS	ST3500514NS
Power-on to ready (sec max)	15	10	7
Standby to ready (sec max)	15	10	7
Track-to-track seek time (ms typical)	0.5 read 0.8 write		
Average seek, read (ms typical)	<8.5		
Average seek, write (ms typical)	<9.5		
Startup current (typical) 12V (peak)	2.8A 2.0A (optional configuration through Smart Command Transport)		
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%		
Ambient temperature	5° to 60°C (operating/tested) –40° to 70°C (nonoperating)		
Temperature gradient (°C per hour max)	20°C (operating) 30°C (nonoperating)		
Relative humidity	5% to 90% (operating) 5% to 95% (nonoperating)		
Relative humidity gradient	30% per hour max		
Altitude, operating	–60.96 m to 3,048 m (–200 ft to 10,000+ ft)		
Altitude, nonoperating (below mean sea level, max)	–60.96 m to 12,192 m (–200 ft to 40,000+ ft)		
Operational Shock (max at 2 ms)	Read 70 Gs / Write 40 Gs		
Non-Operational Shock (max at 2 ms)	300 Gs	350 Gs	
Vibration, operating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs		
Operation Rotational vibration	20–1500Hz: 12.5 rads/s^2		
Vibration, nonoperating	10–500 Hz: 4.9 Grms ref		
Drive acoustics, sound power (bels)			
Idle**	2.7 (typical) 2.9 (max)	2.2 (typical) 2.5 (max)	1.9 (typical) 2.3 (max)
Performance seek	3.0 (typical) 3.3 (max)	2.8 (typical) 3.1 (max)	2.7 (typical) 3.0 (max)
Nonrecoverable read errors	1 sector per 10^{15} bits read		
Annualized Failure Rate (AFR)	0.73% based on 8760 POH		
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp You will be asked to provide the drive serial number, model number (or part number) and country of purchase. After submitting this information, the system will display the warranty information for your drive.		
Load-unload cycles	300,000 (25°C, 50% rel. humidity) (600,000 design life testing)		
Supports Hotplug operation per Serial ATA Revision 2.6 specification	Yes		

*One GB equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

**During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

3.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST32000644NS	2TB	3,907,029,168	512
ST31000524NS	1TB	1,953,525,168	
ST3500514NS	500GB	976,773,168	

*One GB equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

3.2.1 LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to *n–1*, where *n* is the number of guaranteed sectors as defined above.

See Section 5.3.1, "Identify Device command" (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137GB.

3.3 Default logical geometry

Cylinders	Read/write heads	Sectors per track
16,383	16	63

LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to *n–1*, where *n* is the number of guaranteed sectors as defined above.

3.4 Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	Perpendicular
Recording density, KBPI (Kb/in max)	1,421
Track density, KTPI (ktracks/in avg)	240
Areal density (Gb/in^2 avg)	347
Spindle speed (RPM) (± 0.2%)	7200
Internal data transfer rate (Mb/s max)	1300
Sustained data transfer rate (MB/s max)	140
I/O data-transfer rate (MB/s max)	300 (Ultra DMA mode 5)

3.5 Physical characteristics

Maximum height	26.1mm (1.028 in)
Maximum width	101.6mm (4.000 +/- 0.010 in)
Maximum length	146.99mm (5.787 in)
Max weight	
ST32000644NS	710g (1.565 lb)
ST31000524NS	640g (1.411 lb)
ST3500514NS	610g (1.345 lb)
Cache buffer	
ST32000644NS	64MB (64,768KB)
ST31000524NS and ST3500514NS	32MB (32,768KB)

3.6 Seek time

Seek measurements are taken with nominal power at 25°C ambient temperature. All times are measured using drive diagnostics. The specifications in the table below are defined as follows:

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5000 measurements of seeks between random tracks, less overhead.

***Typical seek times (ms)**	**Read**	**Write**
Track-to-track	0.5	0.8
Average	<8.5	<9.5
Average latency:	4.16	

*Measured in performance mode.

Note. These drives are designed to consistently meet the seek times represented in this manual. Physical seeks, regardless of mode (such as track-to-track and average), are expected to meet the noted values. However, due to the manner in which these drives are formatted, benchmark tests that include command overhead or measure logical seeks may produce results that vary from these specifications.

3.7 Start/stop times

	2TB models	**1TB models**	**500GB models**
Power-on to Ready (sec)	15 (max)	10 (max)	7 (max)
Standby to Ready (sec)	15 (max)	10 (max)	7 (max)
Ready to spindle stop (sec)	20 (max)		

3.8 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. See Figure 3 on page 24.

3.8.1 Power consumption

Power requirements for the drives are listed in the table on page 9. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- **Spinup power**

  Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.

- **Seek mode**

  During seek mode, the read/write actuator arm moves toward a specific position on the disc surface and does not execute a read or write operation. Servo electronics are active. Seek mode power represents the worst-case power consumption, using only random seeks with read or write latency time. This mode is not typical and is provided for worst-case information.

- **Read/write power and current**

  Read/write power is measured with the heads on track, based on a 16-sector write followed by a 32-ms delay, then a 16-sector read followed by a 32ms delay.

- **Operating power and current**

  Operating power is measured using 40 percent random seeks, 40 percent read/write mode (1 write for each 10 reads) and 20 percent drive idle mode.

- **Idle mode power**

  Idle mode power is measured with the drive up to speed, with servo electronics active and with the heads in a random track location.

- **Standby mode**

  During Standby mode, the drive accepts commands, but the drive is not spinning, and the servo and read/write electronics are in power-down mode.

Table 2: 2000GB Drive DC power requirements

		1.5Gb mode			3.0Gb mode		
Voltage		**+5V**	**+12V**	**Power**	**+5V**	**+12V**	**Power**
Regulation		**±5%**	**±5%**	**(Watts)**	**±5%**	**±5%**	**(Watts)**
Avg Idle Current *		0.26	0.42	6.38	0.27	0.42	6.39
Advanced Idle Current *							
	Idle_A	0.13	0.35	4.83	0.14	0.42	5.70
	Idle_B	0.13	0.36	5.01	0.14	0.36	5.00
	Idle_C	0.13	0.22	3.26	0.14	0.22	3.27
	Standby	0.09	0.01	0.51	0.09	0.01	0.53
Transition Current *							
	Idle_A (Active)	0.86	1.66	24.22	0.98	0.90	15.70
	Idle_B (Active)	0.76	1.72	24.47	0.74	1.64	23.42
	Idle_C (Active)	0.78	2.48	33.71	0.78	2.50	33.95
	Standby (Active)	0.80	2.64	35.71	0.82	2.64	35.83
Average Sleep Current		0.09	0.01	0.52	0.09	0.01	0.55
Maximum Start Current							
	DC (peak DC)	0.35	2.03	26.13	0.36	2.03	26.24
	AC (Peak DC)	0.59	2.66	34.91	0.61	2.64	34.77
Delayed Motor Start (DC max)		0.09	0.01	0.55	0.09	0.01	0.57
Peak operating current (random read):							
	Typical DC	0.30	0.63	9.02	0.30	0.63	9.03
	Maximum DC	0.30	0.64	9.21	0.31	0.64	9.22
	Maximum DC(peak)	1.04	1.88	27.78	1.06	1.88	27.86
Peak operating current (random write)							
	Typical DC	0.30	0.52	7.78	0.31	0.52	7.80
	Maximum DC	0.31	0.53	7.90	0.31	0.53	7.95
	Maximum DC(peak)	1.40	1.86	29.32	1.44	1.84	29.28
Peak operating current (sequential read)							
	Typical DC	0.65	0.44	8.56	0.65	0.44	8.54
	Maximum DC	0.67	0.45	8.78	0.67	0.44	8.67
	Maximum DC(peak)	1.12	0.88	16.16	1.08	0.88	15.96
Peak operating current (sequential write)							
	Typical DC	0.64	0.44	8.52	0.65	0.44	8.52
	Maximum DC	0.66	0.45	8.66	0.66	0.44	8.65
	Maximum DC(peak)	1.44	0.90	18.00	1.44	0.88	17.76

Table 3: 1000GB Drive DC power requirements

		1.5Gb mode			3.0Gb mode		
Voltage		**+5V**	**+12V**	**Power**	**+5V**	**+12V**	**Power**
Regulation		**±5%**	**±5%**	**(Watts)**	**±5%**	**±5%**	**(Watts)**
Avg Idle Current *		0.27	0.27	4.59	0.27	0.27	4.61
Advanced Idle Current *							
	Idle_A	0.14	0.27	3.86	0.15	0.27	3.99
	Idle_B	0.14	0.23	3.53	0.15	0.23	3.56
	Idle_C	0.14	0.08	1.70	0.15	0.08	1.73
	Standby	0.09	0.01	0.54	0.10	0.01	0.57
Transition Current *							
	Idle_A (Active)	0.86	0.98	16.06	0.86	1.06	17.02
	Idle_B (Active)	0.80	1.32	19.90	0.76	1.27	19.02
	Idle_C (Active)	0.76	2.76	36.98	0.82	2.81	37.78
	Standby (Active)	0.78	2.99	39.73	0.78	3.01	39.98
Average Sleep Current		0.09	0.01	0.57	0.10	0.01	0.59
Maximum Start Current							
	DC (peak DC)	0.38	2.05	26.44	0.38	2.05	26.45
	AC (Peak DC)	0.59	2.98	38.76	0.69	2.99	39.29
Delayed Motor Start (DC max)		0.11	0.01	0.66	0.11	0.01	0.64
Peak operating current (random read):							
	Typical DC	0.30	0.49	7.41	0.31	0.49	7.42
	Maximum DC	0.31	0.50	7.52	0.32	0.50	7.56
	Maximum DC(peak)	0.96	1.54	23.28	0.96	1.54	23.28
Peak operating current (random write)							
	Typical DC	0.32	0.38	6.20	0.33	0.38	6.21
	Maximum DC	0.33	0.39	6.30	0.34	0.39	6.34
	Maximum DC(peak)	1.30	1.58	25.46	1.30	1.58	25.46
Peak operating current (sequential read)							
	Typical DC	0.65	0.28	6.64	0.65	0.28	6.63
	Maximum DC	0.66	0.29	6.75	0.67	0.28	6.74
	Maximum DC(peak)	1.00	0.62	12.44	1.02	0.62	12.54
Peak operating current (sequential write)							
	Typical DC	0.68	0.28	6.79	0.68	0.28	6.78
	Maximum DC	0.70	0.29	6.92	0.70	0.28	6.90
	Maximum DC(peak)	1.26	0.74	15.18	1.28	0.60	13.60

Table 4: 500GB Drive DC power requirements

		1.5Gb mode			3.0Gb mode		
Voltage		**+5V**	**+12V**	**Power**	**+5V**	**+12V**	**Power**
Regulation		**±5%**	**±5%**	**(Watts)**	**±5%**	**±5%**	**(Watts)**
Avg Idle Current *		0.26	0.20	3.71	0.28	0.20	3.74
Advanced Idle Current *							
	Idle_A	0.13	0.21	3.13	0.14	0.21	3.17
	Idle_B	0.13	0.18	2.82	0.14	0.18	2.85
	Idle_C	0.13	0.07	1.50	0.14	0.07	1.52
	Standby	0.09	0.01	0.53	0.09	0.01	0.55
Transition Current *							
	Idle_A (Active)	0.84	0.52	10.44	0.84	0.54	10.68
	Idle_B (Active)	0.70	1.11	16.81	0.80	1.13	17.56
	Idle_C (Active)	0.70	2.45	32.91	0.72	2.43	32.77
	Standby (Active)	0.80	2.59	35.08	0.84	2.59	35.28
Average Sleep Current		0.09	0.01	0.54	0.09	0.01	0.56
Maximum Start Current							
	DC (peak DC)	0.36	2.03	26.14	0.36	2.03	26.14
	AC (Peak DC)	0.55	2.59	33.83	0.63	2.59	34.24
Delayed Motor Start (DC max)		0.09	0.01	0.55	0.09	0.01	0.59
Peak operating current (random read):							
	Typical DC	0.29	0.42	6.45	0.29	0.42	6.47
	Maximum DC	0.30	0.42	6.56	0.30	0.42	6.54
	Maximum DC(peak)	1.00	1.38	27.56	1.00	1.38	21.32
Peak operating current (random write)							
	Typical DC	0.31	0.32	5.32	0.31	0.31	5.31
	Maximum DC	0.31	0.33	5.48	0.31	0.32	5.45
	Maximum DC(peak)	1.20	1.40	22.80	1.20	1.38	22.56
Peak operating current (sequential read)							
	Typical DC	0.62	0.21	5.63	0.62	0.21	5.62
	Maximum DC	0.63	0.21	5.72	0.63	0.21	5.72
	Maximum DC(peak)	1.02	0.46	10.62	1.02	0.46	10.62
Peak operating current (sequential write)							
	Typical DC	0.66	0.21	5.84	0.66	0.21	5.82
	Maximum DC	0.67	0.21	5.92	0.67	0.21	5.89
	Maximum DC(peak)	1.34	0.46	12.22	1.30	0.48	12.26

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

3.8.1.1 Typical current profiles

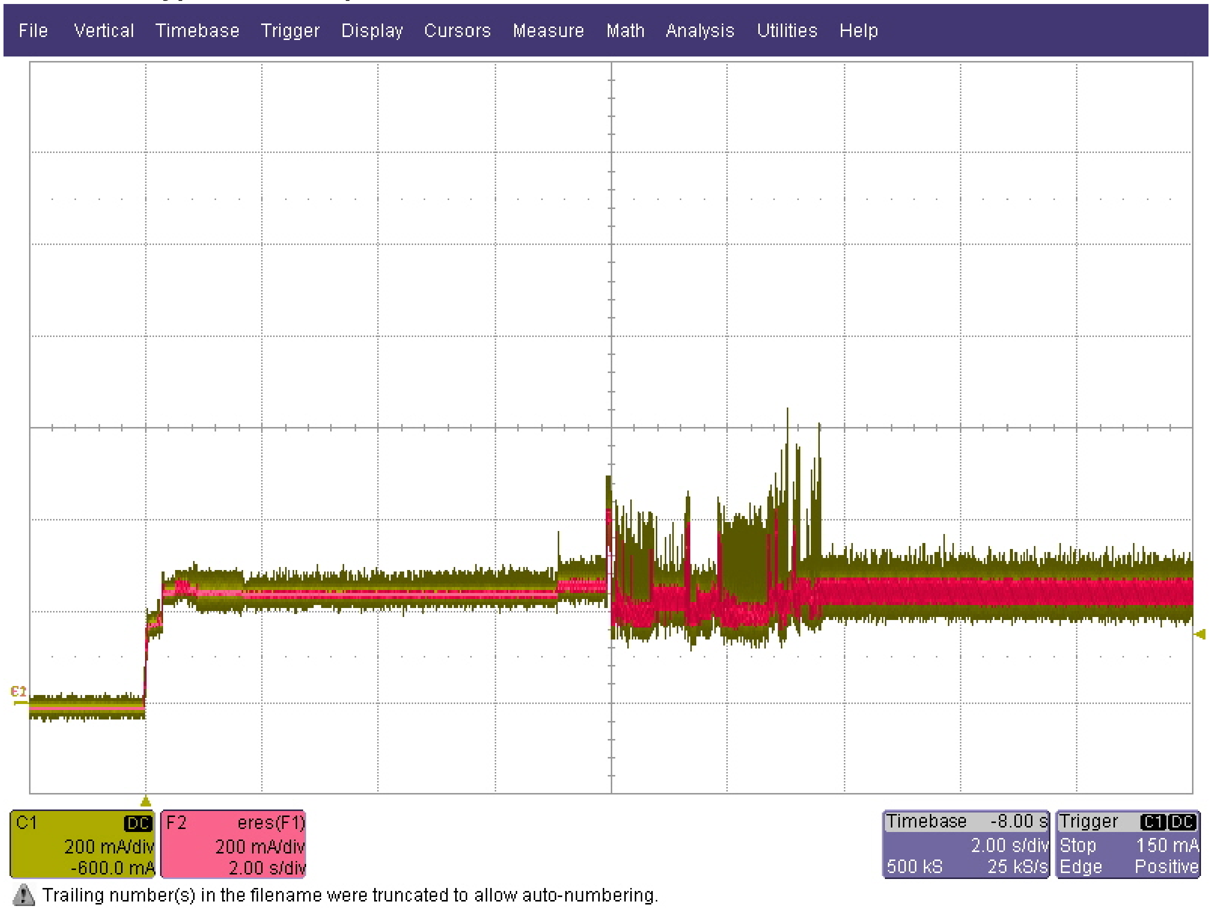


Figure 1. Typical 5V startup and operation current profile



Figure 2. Typical 12V startup and operation current profile

3.8.2 Conducted noise

Input noise ripple is measured at the host system power supply across an equivalent 80-ohm resistive load on the +12 V line or an equivalent 15-ohm resistive load on the +5V line.

- Using 12V power, the drive is expected to operate with a maximum of 120mV peak-to-peak square-wave injected noise at up to 10MHz.
- Using 5V power, the drive is expected to operate with a maximum of 100mV peak-to-peak square-wave injected noise at up to 10MHz.

Note. Equivalent resistance is calculated by dividing the nominal voltage by the typical RMS read/write current.

3.8.3 Voltage tolerance

Voltage tolerance (including noise):

5V ± 5%
12V ±10%

3.8.4 Power-management modes

The drive provides programmable power management to provide greater energy efficiency. In most systems, you can control power management through the system setup program. The drive features the following power-management modes:

Power modes	Heads	Spindle	Buffer
Active	Tracking	Rotating	Enabled
Idle_a	ID Biased	Rotating	Enabled
Idle_b	Parked	Rotating	Enabled
Idle_c	Parked	Rotating at lower RPM	Enabled
Standby	Parked	Stopped	Enabled
Sleep	Parked	Stopped	Disabled

- **Active mode**
  The drive is in Active mode during the read/write and seek operations.
- **Idle mode**
  The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disc access is necessary.
- **Standby mode**
  The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the drive buffer is enabled, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disc access is necessary.
- **Sleep mode**
  The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the drive buffer is disabled, the heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Standby mode with all current translation parameters intact.
- **Idle and Standby timers**
  Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disc access is necessary.

3.8.4.1 Extended Power Conditions - PowerChoice™

Utilizing the load/unload architecture a programmable power management interface is provided to tailor systems for reduced power consumption and performance requirements.

The table below lists the supported power conditions available in PowerChoice. Power conditions are ordered from highest power consumption (and shortest recovery time) to lowest power consumption (and longest recovery time) as follows: Idle_a power >= Idle_b power >= Idle_c power >= Standby_z power. The further you go down in the table, the more power savings is actualized. For example, Idle_b results in greater power savings than the Idle_a power condition. Standby results in the greatest power savings.

Power Condition Name	Power Condition ID	Description
Idle_a	81_H	Reduced electronics
Idle_b	82_H	Heads unloaded. Disks spinning at full RPM
Idle_c	83_H	Heads unloaded. Disks spinning at reduced RPM
Standby_z	00_H	Heads unloaded. Motor stopped (disks not spinning)

Each power condition has a set of current, saved and default settings. Default settings are not modifiable. Default and saved settings persist across power-on resets. The current settings do not persist across power-on resets. At the time of manufacture, the default, saved and current settings are in the Power Conditions log match.

PowerChoice is invoked using one of two methods

- Automatic power transitions which are triggered by expiration of individual power condition timers. These timer values may be customized and enabled using the Extended Power Conditions (EPC) feature set using the standardized Set Features command interface.
- Immediate host commanded power transitions may be initiated using an EPC Set Features "Go to Power Condition" subcommand to enter any supported power condition. Legacy power commands Standby Immediate and Idle Immediate also provide a method to directly transition the drive into supported power conditions.

PowerChoice exits power saving states under the following conditions

- Any command which requires the drive to enter the PM0: Active state (media access)
- Power on reset

PowerChoice provides the following reporting methods for tracking purposes

Check Power Mode Command

- Reports the current power state of the drive

Identify Device Command

- EPC Feature set supported flag
- EPC Feature enabled flag is set if at least one Idle power condition timer is enabled

Power Condition Log reports the following for each power condition

- Nominal recovery time from the power condition to active
- If the power condition is Supported, Changeable, and Savable
- Default enabled state, and timer value
- Saved enabled state, and timer value
- Current enabled state, and timer value

S.M.A.R.T. Read Data Reports

- Attribute 192 - Emergency Retract Count
- Attribute 193 - Load/Unload Cycle Count

PowerChoice Manufacture Default Power Condition Timer Values

Default power condition timer values have been established to assure product reliability and data integrity. A minimum timer value threshold of two minutes ensures the appropriate amount of background drive maintenance activities occur. Attempting to set a timer values less than the specified minimum timer value threshold will result in an aborted EPC "Set Power Condition Timer" subcommand.

Power Condition Name	Manufacturer Default Timer Values
Idle_a	2 min
Idle_b	4 min
Idle_c	10 min
Standby_z	15 min

Setting power condition timer values less than the manufacturer specified defaults or issuing the EPC "Go to Power Condition" subcommand at a rate exceeding the default timers may limit this products reliability and data integrity.

PowerChoice Supported Extended Power Condition Feature Subcommands

EPC Subcommand	Description
00_H	Restore Power Condition Settings
01_H	Go to Power Condition
02_H	Set Power Condition Timer
03_H	Set Power Condition State

PowerChoice Supported Extended Power Condition Indentifiers

Power Condition Identifiers	Power Condition Name
00_H	Standby_z
$01 - 80_H$	Reserved
81_H	Idle_a
82_H	Idle_b
83_H	Idle_c
$84 - FE_H$	Reserved
FF_H	All EPC Power Conditions

3.9 Environmental limits

Temperature and humidity values experienced by the drive must be such that condensation does not occur on any drive part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7°F (14.8°C). Maximum wet bulb temperature is 82°F (28°C).

3.9.1 Temperature

a. Operating

To obtain optimal performance, drives should be run at nominal case temperatures.

With cooling designed to maintain the case temperatures, the drive meets all specifications over a 41°F to 140°F (5°C to 60°C) drive ambient temperature range with a maximum temperature gradient of 36°F (20°C) per hour. The enclosure for the drive should be designed such that these temperatures not exceeded. Air flow may be needed to achieve these temperature values. Operation at case temperatures above these values may adversely affect the drives ability to meet specifications.

The MTBF specification for the drive is based on operating in an environment that ensures that the case temperatures are not exceeded. Occasional excursions to drive ambient temperatures of 140°F (60°C) or 41°F (5°C) may occur without impact to specified MTBF. Air flow may be needed to achieve these temperatures. Continual or sustained operation at case temperatures above these values may degrade MTBF. The maximum allowable continuous or sustained HDA case temperature for the rated MTBF is 104°F (40°C).

To confirm that the required cooling for the electronics and HDA is provided, place the drive in its final mechanical configuration, perform random write/read operations. After the temperatures stabilize, measure the case temperature of the drive.

The maximum allowable HDA case temperature is 60°C. Operation of the drive at the maximum case temperature is intended for short time periods only. Continuous operation at the elevated temperatures will reduce product reliability.

b. Non-operating

–40° to 158°F (–40° to 70°C) package ambient with a maximum gradient of 36°F (20°C) per hour. This specification assumes that the drive is packaged in the shipping container designed by Seagate for use with drive.

3.9.2 Humidity

3.9.2.1 Relative humidity

Operating:	5% to 90% noncondensing (30% per hour max)
Nonoperating:	5% to 95% noncondensing (30% per hour max)

3.9.3 Altitude

Operating:	–60.96 m to 3,048 m (–200 ft. to 10,000+ ft.)
Nonoperating:	–60.96 m to 12,192 m (–200 ft. to 40,000+ ft.)

3.9.4 Shock

All shock specifications assume that the drive is mounted securely with the input shock applied at the drive mounting screws. Shock may be applied in the X, Y or Z axis.

3.9.4.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 70 Gs (read) and 40 Gs (write) based on half-sine shock pulses of 2ms. Shocks should not be repeated more than two times per second.

3.9.4.2 Nonoperating shock

1TB and 500GB models

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 350 Gs based on a nonrepetitive half-sine shock pulse of 2ms duration.

2TB models

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 300 Gs based on a nonrepetitive half-sine shock pulse of 2ms duration.

3.9.5 Vibration

All vibration specifications assume that the drive is mounted securely with the input vibration applied at the drive mounting screws. Vibration may be applied in the X, Y or Z axis.

3.9.5.1 Operating vibration

The maximum vibration levels that the drive may experience while meeting the performance standards specified in this document are specified below.

5–22 Hz	0.25 Gs
22–350 Hz	0.50 Gs
350–500 Hz	0.25 Gs
20 - 1500Hz *(RROV)	12.5 rads/s^2 w/RVFF

* Rotary Random Operating Vibration

3.9.5.2 Nonoperating vibration

The maximum nonoperating vibration levels that the drive may experience without incurring physical damage or degradation in performance when subsequently put into operation are specified below.

10–500 Hz Linear Random	4.9 Grms ref

3.10 Acoustics

Drive acoustics are measured as overall A-weighted acoustic sound power levels (no pure tones). All measurements are consistent with ISO document 7779. Sound power measurements are taken under essentially free-field conditions over a reflecting plane. For all tests, the drive is oriented with the cover facing upward.

Note. For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation:

(Number of seeks per second = 0.4 / (average latency + average access time)

Table 5: Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	Performance seek
ST32000644NS	2.7 bels (typ) 2.9 bels (max)	3.0 bels (typ) 3.3 bels (max)
ST31000524NS	2.2 bels (typ) 2.5 bels (max)	2.8 bels (typ) 3.1 bels (max)
ST3500514NS	1.9 bels (typ) 2.3 bels (max)	2.7 bels (typ) 3.0 bels (max)

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

3.11 Test for Prominent Discrete Tones (PDTs)

Seagate follows the ECMA-74 standards for measurement and identification of PDTs. An exception to this process is the use of the absolute threshold of hearing. Seagate uses this threshold curve (originated in ISO 389-7) to discern tone audibility and to compensate for the inaudible components of sound prior to computation of tone ratios according to Annex D of the ECMA-74 standards.

3.12 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in the following table:

Table 6: Radio frequency environments

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV	B	EN 61000-4-2: 95
Radiated RF immunity	80 to 1000 MHz, 3 V/m, 80% AM with 1 kHz sine 900 MHz, 3 V/m, 50% pulse modulation @ 200 Hz	A	EN 61000-4-3: 96 ENV 50204: 95
Electrical fast transient	± 1 kV on AC mains, ± 0.5 kV on external I/O	B	EN 61000-4-4: 95
Surge immunity	± 1 kV differential, ± 2 kV common, AC mains	B	EN 61000-4-5: 95
Conducted RF immunity	150 kHz to 80 MHz, 3 Vrms, 80% AM with 1 kHz sine	A	EN 61000-4-6: 97
Voltage dips, interrupts	0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN 61000-4-11: 94

3.13 Reliability

3.13.1 Annualized Failure Rate (AFR) and Mean Time Between Failures (MTBF)

The product shall achieve an Annualized Failure Rate (AFR) of 0.73% (MTBF of 1.2 million hours) when operated nominal power and typical case temperatures of 40°C. Operation at temperatures outside the specifications in Section 3.9 may increase the product AFR (decrease MTBF). AFR and MTBF are population statistics that are not relevant to individual units.

AFR and MTBF specifications are based on the following assumptions for business critical storage system environments:

- 8,760 power-on-hours per year.
- Operations at nominal voltages.
- Temperatures outside the specifications in Section 3.9 may reduce thee product reliability.
- Normal I/O duty cycle for enterprise nearline applications. Operation at excessive I/O duty cycle may degrade product reliability.

The enterprise application nearline environment of power-on-hours, temperature, and I/O duty cycle affect the product AFR and MTBF.

Nonrecoverable read errors	1 per 10^{15} bits read, max
Annualized Failure Rate (AFR)	0.73% (nominal power, 40°C case temperature)
Load unload cycles	300,000 cycles
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the "Verify Your Warranty" link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase.The system will display the warranty information for your drive.
Preventive maintenance	None required.

3.14 Agency certification

3.14.1 Safety certification

These products are certified to meet the requirements of UL60950-1, CSA60950-1 and EN60950 and so marked as to the certify agency.

3.14.2 Electromagnetic compatibility

Hard drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2004/108/EC) as put into place 20 July 2007. Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55022, Class B and the immunity levels are defined by EN 55024.

Drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with the directives when used in the test systems, we cannot guarantee that all systems will comply with the directives. The drive is designed for operation inside a properly designed enclosure, with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for their products.

Korean RRL

If these drives have the Korean Communications Commission (KCC) logo, they comply with paragraph 1 of Article 11 of the Electromagnetic Compatibility control Regulation and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Laboratory (RRL) Communications Commission, Republic of Korea.

These drives have been tested and comply with the Electromagnetic Interference/Electromagnetic Susceptibility (EMI/EMS) for Class B products. Drives are tested in a representative, end-user system by a Korean-recognized lab.

- Family name: Constellation ES
- Certificate number: STX-Constell-ES (B)

Australian C-Tick (N176)

If these models have the C-Tick marking, they comply with the Australia/New Zealand Standard AS/NZ CISPR22 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).

3.14.3 FCC verification

These drives are intended to be contained solely within a personal computer or similar enclosure (not attached as an external device). As such, each drive is considered to be a subassembly even when it is individually marketed to the customer. As a subassembly, no Federal Communications Commission verification or certification of the device is required.

Seagate has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disc drive, motherboard, power supply, etc.) does comply with the limits for a Class B computing device, pursuant to Subpart J, Part 15 of the FCC rules. Operation with noncertified assemblies is likely to result in interference to radio and television reception.

Radio and television interference. This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer’s instructions, may cause interference to radio and television reception.

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, you are encouraged to try one or more of the following corrective measures:

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

3.15 Environmental protection

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances.

3.15.1 European Union Restriction of Hazardous Substances (RoHS) Directive

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances. A new law, the European Union Restriction of Hazardous Substances (RoHS) Directive, restricts the presence of chemical substances, including Lead, Cadmium, Mercury, Hexavalent Chromium, PBB and PBDE, in electronic products, effective July 2006. This drive is manufactured with components and materials that comply with the RoHS Directive.

3.15.2 China Restriction of Hazardous Substances (RoHS) Directive 中国限制危险物品的指令

This product has an Environmental Protection Use Period (EPUP) of 20 years. The following table contains information mandated by China's "Marking Requirements for Control of Pollution Caused by Electronic Information Products" Standard.

该产品具有20年的环境保护使用周期 （EPUP）。 下表包含了中国 “电子产品所导致的污染的控制的记号要求”所指定的信息。

Name of Parts 部件名称	Toxic or Hazardous Substances or Elements有毒有害物质或元素					
	Lead 铅 (Pb)	Mercury 汞 (Hg)	Cadmium 镉 (Cd)	Hexavalent Chromium 六价铬 (Cr6+)	Polybrominated Biphenyl 多溴联苯 (PBB)	Polybrominated Diphenyl Ether 多溴二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
HDA	X	O	O	O	O	O

"O" indicates the hazardous and toxic substance content of the part (at the homogenous material level) is lower than the threshold defined by the China RoHS MCV Standard.

O"表示该部件（于同类物品程度上）所含的危险和有毒物质低于中国RoHS MCV标准所定义的门槛值。

"X" indicates the hazardous and toxic substance content of the part (at the homogenous material level) is over the threshold defined by the China RoHS MCV Standard.

X "表示该部件（于同类物品程度上）所含的危险和有毒物质超出中国RoHS MCV标准所定义的门槛值。

3.16 Corrosive environment

Seagate electronic drive components pass accelerated corrosion testing equivalent to 10 years exposure to light industrial environments containing sulfurous gases, chlorine and nitric oxide, classes G and H per ASTM B845. However, this accelerated testing cannot duplicate every potential application environment. Users should use caution exposing any electronic components to uncontrolled chemical pollutants and corrosive chemicals as electronic drive component reliability can be affected by the installation environment. The silver, copper, nickel and gold films used in Seagate products are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. In addition, electronic components should never be exposed to condensing water on the surface of the printed circuit board assembly (PCBA) or exposed to an ambient relative humidity greater than 95%. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.

4.0 Configuring and mounting the drive

This section contains the specifications and instructions for configuring and mounting the drive.

4.1 Handling and static-discharge precautions

After unpacking, and before installation, the drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. Observe the following standard handling and static-discharge precautions:

Caution:

- Before handling the drive, put on a grounded wrist strap, or ground yourself frequently by touching the metal chassis of a computer that is plugged into a grounded outlet. Wear a grounded wrist strap throughout the entire installation procedure.
- Handle the drive by its edges or frame *only*.
- The drive is extremely fragile—handle it with care. Do not press down on the drive top cover.
- Always rest the drive on a padded, antistatic surface until you mount it in the computer.
- Do not touch the connector pins or the printed circuit board.
- Do not remove the factory-installed labels from the drive or cover them with additional labels. Removal voids the warranty. Some factory-installed labels contain information needed to service the drive. Other labels are used to seal out dirt and contamination.

4.2 Configuring the drive

Each drive on the Serial ATA interface connects point-to-point with the Serial ATA host adapter. There is no master/slave relationship because each drive is considered a master in a point-to-point relationship. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. Both drives behave as if they are Device 0 (master) devices.

4.3 Serial ATA cables and connectors

The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 in). See Table 7 for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

For direct backplane connection, the drive connectors are inserted directly into the host receptacle. The drive and the host receptacle incorporate features that enable the direct connection to be hot pluggable and blind mateable.

For installations which require cables, you can connect the drive as illustrated in Figure 3.

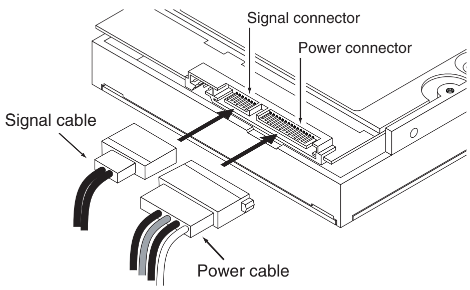


Figure 3. Attaching SATA cabling

Each cable is keyed to ensure correct orientation. Constellation ES Serial ATA drives support latching SATA connectors.

4.4 Drive mounting

You can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See Figure 4 for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 in (0.76mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.150 in (3.81mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 in-lb).

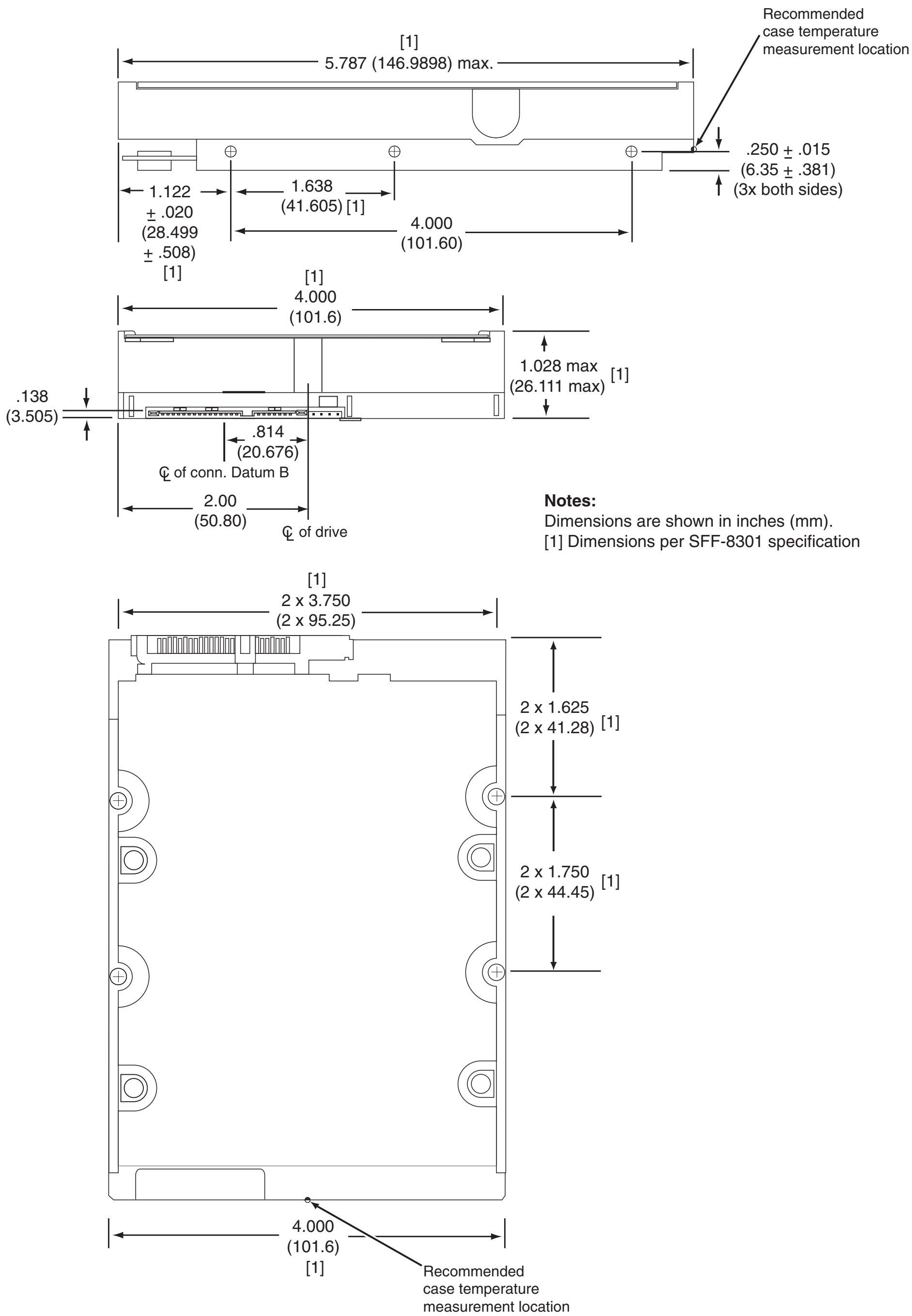


Figure 4. Mounting dimensions—top, side and end view

5.0 Serial ATA (SATA) interface

These drives use the industry-standard Serial ATA interface that supports FIS data transfers. It supports ATA programmed input/output (PIO) modes 0–4; multiword DMA modes 0–2, and Ultra DMA modes 0–6.

For detailed information about the Serial ATA interface, refer to the “Serial ATA: High Speed Serialized AT Attachment” specification.

5.1 Hot-Plug compatibility

Constellation ES Serial ATA drives incorporate connectors which enable you to hot plug these drives in accordance with the Serial ATA Revision 2.6 specification. This specification can be downloaded from www.serial-ata.org.

Caution:

> The drive motor must come to a complete stop **(Ready to spindle stop time indicated in Section 3.7)** prior to changing the plane of operation. This time is required to insure data integrity.

5.2 Serial ATA device plug connector pin definitions

Table 7 summarizes the signals on the Serial ATA interface and power connectors.

Table 7: Serial ATA connector pin definitions

Segment	Pin	Function	Definition
	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pair B from Phy
	S6	B+	
Signal	S7	Ground	2nd mate
Key and spacing separate signal and power segments			
	P1	V_{33}	3.3V power
	P2	V_{33}	3.3V power
	P3	V_{33}	3.3V power, pre-charge, 2nd mate
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V_5	5V power, pre-charge, 2nd mate
Power	P8	V_5	5V power
	P9	V_5	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive does not use deferred spin
	P12	Ground	1st mate.
	P13	V_{12}	12V power, pre-charge, 2nd mate
	P14	V_{12}	12V power
	P15	V_{12}	12V power

Notes:

1. All pins are in a single row, with a 1.27mm (0.050”) pitch.
2. The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
   - the ground pins P4 and P12.
   - the pre-charge power pins and the other ground pins.
   - the signal pins and the rest of the power pins.
3. There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
4. All used voltage pins (V_x) must be terminated.

5.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA: High Speed Serialized AT Attachment specification. See "S.M.A.R.T. commands" on page 35.for details and subcommands used in the S.M.A.R.T. implementation.

Table 8: Supported ATA commands

Command name	Command code (in hex)
Check Power Mode	$E5_H$
Device Configuration Freeze Lock	$B1_H$ / $C1_H$
Device Configuration Identify	$B1_H$ / $C2_H$
Device Configuration Restore	$B1_H$ / $C0_H$
Device Configuration Set	$B1_H$ / $C3_H$
Device Reset	08_H
Download Microcode	92_H
Execute Device Diagnostics	90_H
Flush Cache	$E7_H$
Flush Cache Extended	EA_H
Format Track	50_H
Identify Device	EC_H
Idle	$E3_H$
Idle Immediate	$E1_H$
Initialize Device Parameters	91_H
Read Buffer	$E4_H$
Read DMA	$C8_H$
Read DMA Extended	25_H
Read DMA Without Retries	$C9_H$
Read Log Ext	$2F_H$
Read Multiple	$C4_H$
Read Multiple Extended	29_H
Read Native Max Address	$F8_H$
Read Native Max Address Extended	27_H
Read Sectors	20_H
Read Sectors Extended	24_H
Read Sectors Without Retries	21_H
Read Verify Sectors	40_H
Read Verify Sectors Extended	42_H
Read Verify Sectors Without Retries	41_H
Recalibrate	10_H
Security Disable Password	$F6_H$
Security Erase Prepare	$F3_H$
Security Erase Unit	$F4_H$

Command name	Command code (in hex)
Security Freeze	$F5_H$
Security Set Password	$F1_H$
Security Unlock	$F2_H$
Seek	70_H
Set Features	EF_H
Set Max Address Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	$F9_H$ Address: 00_H Password: 01_H Lock: 02_H Unlock: 03_H Freeze Lock: 04_H
Set Max Address Extended Set Multiple Mode	37_H $C6_H$
Sleep	$E6_H$
S.M.A.R.T. Disable Operations	$B0_H$ / $D9_H$
S.M.A.R.T. Enable/Disable Autosave	$B0_H$ / $D2_H$
S.M.A.R.T. Enable Operations	$B0_H$ / $D8_H$
S.M.A.R.T. Execute Offline	$B0_H$ / $D4_H$
S.M.A.R.T. Read Attribute Thresholds	$B0_H$ / $D1_H$
S.M.A.R.T. Read Data	$B0_H$ / $D0_H$
S.M.A.R.T. Read Log Sector	$B0_H$ / $D5_H$
S.M.A.R.T. Return Status	$B0_H$ / DA_H
S.M.A.R.T. Save Attribute Values	$B0_H$ / $D3_H$
S.M.A.R.T. Write Log Sector	$B0_H$ / $D6_H$
Standby	$E2_H$
Standby Immediate	$E0_H$
Write Buffer	$E8_H$
Write DMA	CA_H
Write DMA Extended	35_H
Write DMA FUA Extended	$3D_H$
Write DMA Without Retries	CB_H
Write Log Extended	$3F_H$
Write Multiple	$C5_H$
Write Multiple Extended	39_H
Write Multiple FUA Extended	CE_H
Write Sectors	30_H
Write Sectors Without Retries	31_H
Write Sectors Extended	34_H
Write Uncorrectable	45_H

5.3.1 Identify Device command

The Identify Device command (command code EC_H) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in Table 8 on page 28. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive. See Section 3.0 on page 4 for default parameter settings.

The following commands contain drive-specific features that may not be included in the Serial ATA specification.

Word	Description	Value
0	Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	$0C5A_H$
1	Number of logical cylinders	16,383
2	ATA-reserved	0000_H
3	Number of logical heads	16
4	Retired	0000_H
5	Retired	0000_H
6	Number of logical sectors per logical track: 63	$003F_H$
7–9	Retired	0000_H
10–19	Serial number: (20 ASCII characters, 0000_H = none)	ASCII
20	Retired	0000_H
21	Retired	0400_H
22	Obsolete	0000_H
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010_H
48	Reserved	0000_H
49	Standard Standby timer, IORDY supported and may be disabled	$2F00_H$
50	ATA-reserved	0000_H
51	PIO data-transfer cycle timing mode	0200_H
52	Retired	0200_H
53	Words 54–58, 64–70 and 88 are valid	0007_H
54	Number of current logical cylinders	$xxxx_H$
55	Number of current logical heads	$xxxx_H$
56	Number of current logical sectors per logical track	$xxxx_H$
57–58	Current capacity in sectors	$xxxx_H$
59	Number of sectors transferred during a Read Multiple or Write Multiple command	$xxxx_H$

Word	Description	Value
60–61	Total number of user-addressable LBA sectors available (see Section 3.2 for related information) *Note: The maximum value allowed in this field is: 0FFFFFFFh (268,435,455 sectors, 137GB). Drives with capacities over 137GB will have 0FFFFFFFh in this field and the actual number of user-addressable LBAs specified in words 100-103. This is required for drives that support the 48-bit addressing feature.	0FFFFFFFh*
62	Retired	0000_H
63	Multiword DMA active and modes supported (see note following this table)	$xx07_H$
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003_H
65	Minimum multiword DMA transfer cycle time per word (120 ns)	0078_H
66	Recommended multiword DMA transfer cycle time per word (120 ns)	0078_H
67	Minimum PIO cycle time without IORDY flow control (240 ns)	$00F0_H$
68	Minimum PIO cycle time with IORDY flow control (120 ns)	0078_H
69–74	ATA-reserved	0000_H
75	Queue depth	$001F_H$
76	Serial ATA capabilities	$xxxx_H$
77	Reserved for future Serial ATA definition	$xxxx_H$
78	Serial ATA features supported	$xxxx_H$
79	Serial ATA features enabled	$xxxx_H$
80	Major version number	$003E_H$
81	Minor version number	0028_H
82	Command sets supported	$364B_H$
83	Command sets supported	$7C03_H$
84	Command sets support extension (see note following this table)	4003_H See Word 108-111 note. (4003H = 0100000000000011 binary)
85	Command sets enabled	$30xx_H$
86	Command sets enabled	0001_H
87	Command sets enable extension	4000_H
88	Ultra DMA support and current mode (see note following this table)	$xx3F_H$
89	Security erase time	0000_H
90	Enhanced security erase time	0000_H
92	Master password revision code	$FFFE_H$
93	Hardware reset value	$xxxx_H$
95–99	ATA-reserved	0000_H
100–103	Total number of user-addressable LBA sectors available (see Section 3.2 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh.	ST32000644NS = 3,907,029,168 ST31000524NS = 1,953,525,168 ST3500514NS = 976,773,168
104–107	ATA-reserved	0000_H

Word	Description	Value
108–111	The mandatory value of the world wide name (WWN) for the drive. NOTE: This field is valid if word 84, bit 8 is set to 1 indicating 64-bit WWN support.	Each drive will have a unique value.
112–127	ATA-reserved	0000_H
128	Security status	0001_H
129–159	Seagate-reserved	$xxxx_H$
160–254	ATA-reserved	0000_H
255	Integrity word	$xxA5_H$

Note. See the bit descriptions below for words 63, 84, and 88 of the Identify Drive data.

Description (if bit is set to 1)		
	Bit	**Word 63**
	0	Multiword DMA mode 0 is supported.
	1	Multiword DMA mode 1 is supported.
	2	Multiword DMA mode 2 is supported.
	8	Multiword DMA mode 0 is currently active.
	9	Multiword DMA mode 1 is currently active.
	10	Multiword DMA mode 2 is currently active.
	Bit	**Word 84**
	0	SMART error logging is supported.
	1	SMART self-test is supported.
	2	Media serial number is supported.
	3	Media Card Pass Through Command feature set is supported.
	4	Streaming feature set is supported.
	5	GPL feature set is supported.
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported.
	7	WRITE DMA QUEUED FUA EXT command is supported.
	8	64-bit World Wide Name is supported.
	9-10	Obsolete.
	11-12	Reserved for TLC.
	13	IDLE IMMEDIATE command with IUNLOAD feature is supported.
	14	Shall be set to 1.
	15	Shall be cleared to 0.

	Bit	Word 88
	0	Ultra DMA mode 0 is supported.
	1	Ultra DMA mode 1 is supported.
	2	Ultra DMA mode 2 is supported.
	3	Ultra DMA mode 3 is supported.
	4	Ultra DMA mode 4 is supported.
	5	Ultra DMA mode 5 is supported.
	6	Ultra DMA mode 6 is supported.
	8	Ultra DMA mode 0 is currently active.
	9	Ultra DMA mode 1 is currently active.
	10	Ultra DMA mode 2 is currently active.
	11	Ultra DMA mode 3 is currently active.
	12	Ultra DMA mode 4 is currently active.
	13	Ultra DMA mode 5 is currently active.
	14	Ultra DMA mode 6 is currently active.

5.3.2 Set Features command

This command controls the implementation of various features that the drive supports. When the drive receives this command, it sets BSY, checks the contents of the Features register, clears BSY and generates an interrupt. If the value in the register does not represent a feature that the drive supports, the command is aborted. Power-on default has the read look-ahead and write caching features enabled. The acceptable values for the Features register are defined as follows:

Table 9: Set Features command values

02_H Enable write cache *(default).*

03_H Set transfer mode (based on value in Sector Count register).
Sector Count register values:

- 00_H Set PIO mode to default (PIO mode 2).
- 01_H Set PIO mode to default and disable IORDY (PIO mode 2).
- 08_H PIO mode 0
- 09_H PIO mode 1
- $0A_H$ PIO mode 2
- $0B_H$ PIO mode 3
- $0C_H$ PIO mode 4 *(default)*
- 20_H Multiword DMA mode 0
- 21_H Multiword DMA mode 1
- 22_H Multiword DMA mode 2
- 40_H Ultra DMA mode 0
- 41_H Ultra DMA mode 1
- 42_H Ultra DMA mode 2
- 43_H Ultra DMA mode 3
- 44_H Ultra DMA mode 4
- 45_H Ultra DMA mode 5
- 46_H Ultra DMA mode 6

10_H Enable use of SATA features

55_H Disable read look-ahead (read cache) feature.

82_H Disable write cache

90_H Disable use of SATA features

AA_H Enable read look-ahead (read cache) feature *(default).*

$F1_H$ Report full capacity available

Note. At power-on, or after a hardware or software reset, the default values of the features are as indicated above.

5.3.3 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disc drives. When S.M.A.R.T. is enabled, the drive monitors predetermined drive attributes that are susceptible to degradation over time. If self-monitoring determines that a failure is likely, S.M.A.R.T. makes a status report available to the host. Not all failures are predictable. S.M.A.R.T. predictability is limited to the attributes the drive can monitor. For more information on S.M.A.R.T. commands and implementation, see the *Draft ATA-5 Standard.*

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for $D4_H$) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: http://seatools.seagate.com.

This drive is shipped with S.M.A.R.T. features disabled. You must have a recent BIOS or software package that supports S.M.A.R.T. to enable this feature. The table below shows the S.M.A.R.T. command codes that the drive uses.

Table 10: S.M.A.R.T. commands

Code in features register	S.M.A.R.T. command
$D0_H$	S.M.A.R.T. Read Data
$D2_H$	S.M.A.R.T. Enable/Disable Attribute Autosave
$D3_H$	S.M.A.R.T. Save Attribute Values
$D4_H$	S.M.A.R.T. Execute Off-line Immediate (runs DST)
$D5_H$	S.M.A.R.T. Read Log Sector
$D6_H$	S.M.A.R.T. Write Log Sector
$D8_H$	S.M.A.R.T. Enable Operations
$D9_H$	S.M.A.R.T. Disable Operations
DA_H	S.M.A.R.T. Return Status

Note. If an appropriate code is not written to the Features Register, the command is aborted and 0*x*04 (abort) is written to the Error register.

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Publication Number: 100516232, Rev. F